Mapping the ADDQoL to the EQ-5D-5L and SF-6Dv2 among Chinese patients with type 2 diabetes mellitus

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OBJECTIVES

- This study developed mapping algorithms to predict EQ-5D-5L and SF-6Dv2 utility values from ADDQoL scores in Type 2 Diabetes Mellitus (T2DM) patients in China.

METHODS

- 800 T2DM patients were recruited in China, stratified by age, sex, and geographical region, were divided into development (80%) and validation (20%) groups.
- Pearson correlation analyses were conducted to assess the **conceptual overlap** between ADDQoL and the EQ-5D-5L and SF-6Dv2.
- **Six regression methods**, including OLS, Tobit, CLAD, GLM, TPM and Beta Regression Mixture Model. **Six predictor sets** including set 1: ADDQoL AWI; set 2: variables via stepwise regression from 19 WI items; set 3: OI1, OI2, and AWI; set 4: added squared terms to set 3; set 5: added cubic terms to set 3; set 6: OI1, OI2, and stepwise-selected critical WI items. **36 candidate models** were explored to estimate mapping algorithms using the development dataset.
- Model performance was evaluated using average rank of MAE, RMSE and ICC. What's more, predicted utility values had to fall within a reasonable range, and the simplest model was preferred.

RESULTS

- **Socio-demographic characteristics of respondents**
  - A total of **800 T2DM patients** (52.8% male, the mean (SD) age 50.4 (11.9) years, BMI 24.4 (3.8) means overweight) were included.
  - The average score (SD) of **ADDQoL** was **−2.426 (1.052)** and the mean utility value (SD) of **EQ-5D-5L and SF-6Dv2** was 0.928 (0.092) and 0.791 (0.133).
- **Conceptual overlap**
  - As shown in Table 1, moderate correlations (0.3 ≤ r < 0.5) were observed between the utility values of EQ-5D-5L and SF-6Dv2 and the OI1 of ADDQoL

Table 1 Pearson correlation coefficients between ADDQoL and EQ-5D-5L/SF-6Dv2

	EQ-5D-5L						SF-6Dv2						
	MO	SC	UA	PD	AD	Utility	PF	RL	SF	PN	MH	VT	Utility
ADDQoL OI1	-0.229	-0.178	-0.279	-0.317	-0.31	**0.375**	-0.279	-0.368	-0.351	-0.317	-0.299	-0.343	**0.433**
ADDQoL OI2	-0.024	0.024	0.029	0.008	0.016	-0.002	-0.011	-0.026	-0.036	0.003	-0.012	-0.108	0.044
ADDQoL AWI	-0.092	-0.026	-0.074	-0.059	-0.045	0.088	-0.057	-0.095	-0.152	-0.059	-0.076	-0.075	0.106

Abbr: ADDQoL OI1, overview item1; OI2, overview item2; AWI The average weighted impact score of the Audit of Diabetes-Dependent Quality of Life; MO, mobility; SC, Self-care; UA, Usual activities; PD, Pain/Discomfort; AD, Anxiety/Depression; PF, Physical Functioning; RL, Role Limitations; SF, Social Functioning; PN, Pain; MH, Mental Health; VT, Vitality

Table 2 Model performance of six regression methods (best) for mapping the ADDQoL to the EQ-5D-5L utility scores

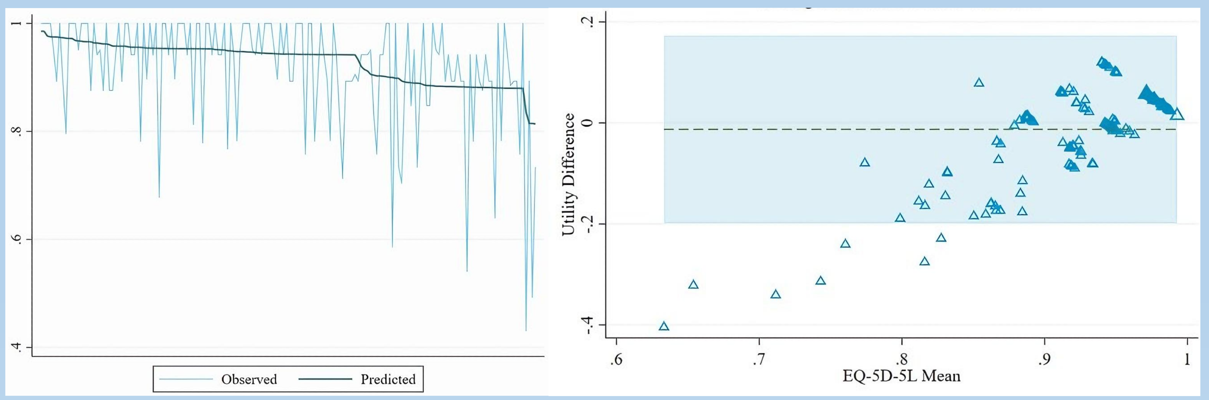
Mapping	Development group (n=640)						Validation group (n=160)					
Methods	Mean (SD)	Min, Max	MAE	RMSE	ICC	AR	Mean (SD)	Min, Max	MAE	RMSE	ICC	AR
OLS4	0.931 (0.037)	0.792,0.980	0.056	0.080	0.461	2	0.928 (0.037)	0.817,0.997	0.067	0.095	0.418	1
Tobit4	0.960 (0.048)	0.791,1.000	0.055	0.086	0.459	8	0.957 (0.048)	0.810,1.000	0.066	0.103	0.384	14
CLAD4	0.952 (0.043)	0.796,1.000	0.054	0.084	0.440	5	0.952 (0.042)	0.838,1.000	0.065	0.103	0.332	13
GLM4	0.947 (0.030)	0.819,0.995	0.055	0.081	0.397	7	0.945 (0.030)	0.834,0.997	0.066	0.099	0.330	10
PTM4	**0.931 (0.036)**	**0.812,0.984**	**0.056**	**0.079**	**0.463**	**1**	**0.929 (0.037)**	**0.814,0.986**	**0.067**	**0.095**	**0.414**	**1**
BM4	0.927 (0.023)	0.835,0.954	0.057	0.081	0.349	17	0.925 (0.023)	0.836,0.955	0.068	0.096	0.319	17

SD standard deviation, Min minimum predicted value, Max. maximum predicted value, AIC Akaike information criteria, BIC Bayesin formation criteria, MAE mean absolute error, RMSE root mean square error, ICC interclass correlation, AR Average rank: Converted from the average ranking score coefficient
1/2/3/4/5/6: Regression model using independent variable set1/2/3/4/5/6
Predictor set in bold indicated the best results among the regression method

Table 3 Model performance of six regression methods (best) for mapping the ADDQoL to the SF-6Dv2 utility scores

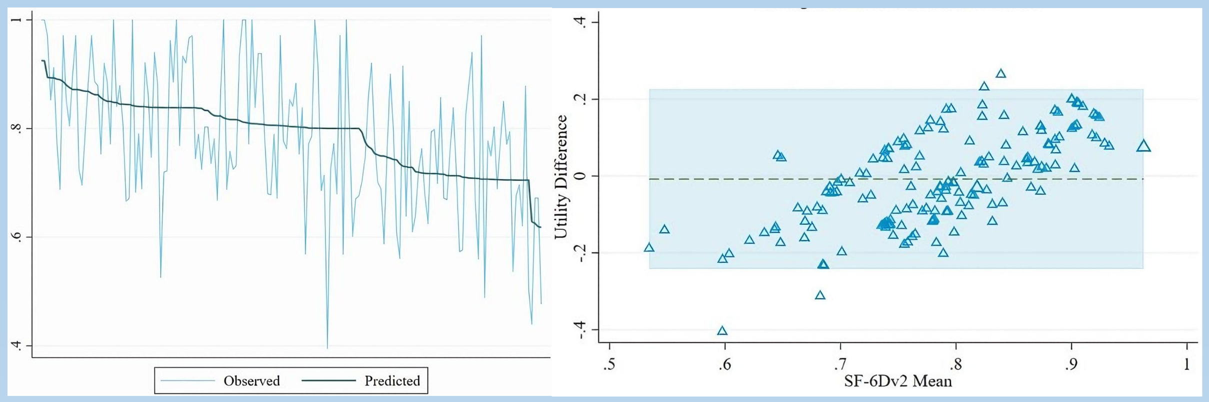
Mapping	Development group (n=640)						Validation group (n=160)					
Methods	Mean (SD)	Min, Max	MAE	RMSE	ICC	AR	Mean (SD)	Min, Max	MAE	RMSE	ICC	AR
OLS4	0.793 (0.063)	0.580,0.924	0.094	0.117	0.535	4	0.791 (0.064)	0.613,0.930	0.100	0.120	0.514	7
Tobit4	0.797 (0.066)	0.576,0.935	0.094	0.117	0.548	4	0.795 (0.067)	0.611,0.942	0.100	0.120	0.522	9
CLAD4	0.789 (0.061)	0.584,0.910	0.094	0.117	0.523	6	0.786 (0.062)	0.607,0.915	0.101	0.120	0.502	17
GLM4	0.800 (0.064)	0.558,0.929	0.094	0.117	0.541	3	0.797 (0.066)	0.604,0.934	0.100	0.121	0.514	16
PTM4	**0.793 (0.063)**	**0.584,0.919**	**0.094**	**0.117**	**0.537**	**1**	**0.790 (0.064)**	**0.618,0.925**	**0.099**	**0.120**	**0.517**	**1**
BM4	0.788 (0.061)	0.541,0.887	0.094	0.117	0.530	2	0.785 (0.062)	0.585,0.890	0.100	0.120	0.506	14

SD standard deviation, Min minimum predicted value, Max. maximum predicted value, AIC Akaike information criteria, BIC Bayesin formation criteria, MAE mean absolute error, RMSE root mean square error, ICC interclass correlation, AR Average rank: Converted from the average ranking score coefficient
1/2/3/4/5/6: Regression model using independent variable set1/2/3/4/5/6
Predictor set in bold indicated the best results among the regression method



7/160 = 4.38% outside the limits of agreement
Mean difference -0.013
95% limits of agreement (-0.198, 0.173)
Averages lie between 0.633 and 0.993

Figure 1 The optimal model performance is mapped onto the utility values of EQ-5D-5L in validation group (N=160)



4/160 = 2.50% outside the limits of agreement
Mean difference -0.008
95% limits of agreement (-0.242, 0.226)
Averages lie between 0.534 and 0.962

Figure 2 The optimal model performance is mapped onto the utility values of SF-6Dv2 in validation group (N=160)

- **Mapping ADDQoL onto EQ-5D-5L utility values**
  - The Best models for each regression method are presented in Table 2. In the development group, **Predictor set 4** consistently emerged as the best-performing predictor set across all regression methods based on AR. While inconsistencies were observed for Tobit (set 6) and CLAD (set 5) in the validation group.
  - **TPM4** demonstrated superior predictive accuracy and consistency in both the development and validation groups, Figure 1 illustrates the performance of the TPM4 in the validation set, which reveal that TPM4 demonstrating greater predictive accuracy and smaller discrepancies.
- **Mapping ADDQoL onto SF-6Dv2 utility values**
  - The Best models for each regression method are presented in Table 3. In the development group, **Predictor set 4** was optimal across all regression methods; in the validation group, only TPM identified it as the best predictor set.
  - Figure 2 further highlight that TPM4 consistently provided predictions more closely aligned with observed.
- **Use of optimal mapping algorithms**
  - The final mapping algorithms from ADDQoL to EQ-5D-5L and SF-6Dv2 utility values are defined as follows:

Defining sign function:

$$sign(x) = \begin{cases} 1, x > 0 \\ 0, x = 0 \\ -1, x < 0 \end{cases}$$

Mapping ADDQoL onto EQ-5D-5L

(1) Prediction probability function:

$$logit(Pr(DisEQ\text{-}5D\text{-}5L)) = 0.4895366 - 1.193757 \times OI1 - 0.7301487 \times AWI + 0.2285856 \times (sign(OI1) \times (OI1)^2) + 0.1427682 \times (sign(AWI) \times (AWI)^2)$$

$$Pr(DisEQ\text{-}5D\text{-}5L > 0) = \frac{1}{1 + e^{-logit(Pr(DisEQ\text{-}5D\text{-}5L>0))}}$$

(2) Expected value prediction of DisEQ-5D-5L:

$$E(DisEQ\text{-}5D\text{-}5L|DisEQ\text{-}5D\text{-}5L > 0) = 0.1055585 - 0.0820005 \times OI1 - 0.0297864 \times AWI + 0.0279237 \times (sign(OI1) \times (OI1)^2) + 0.0050551 \times (sign(AWI) \times (AWI)^2)$$

(3) Transformed EQ-5D-5L utility values:

$$DisEQ\text{-}5D\text{-}5L = Pr(DisEQ\text{-}5D\text{-}5L > 0) \times E(DisEQ\text{-}5D\text{-}5L|DisEQ\text{-}5D\text{-}5L > 0)$$

$$EQ\text{-}5D\text{-}5LUtility = 1 - DisEQ\text{-}5D\text{-}5L$$

Mapping ADDQoL onto SF-6Dv2

(1) Prediction probability function:

$$logit(Pr(DisSF\text{-}6Dv2)) = 3.629165 - 2.230134 \times OI1 - 0.8203494 \times AWI + 0.5761989 \times (sign(OI1) \times (OI1)^2) + 0.2054717 \times (sign(AWI) \times (AWI)^2)$$

$$Pr(DisSF\text{-}6Dv2 > 0) = \frac{1}{1 + e^{-logit(Pr(DisSF\text{-}6Dv2>0))}}$$

(2) Expected value prediction of DisSF-6Dv2:

$$E(DisSF\text{-}6Dv2|DisSF\text{-}6Dv2 > 0) = 0.2090763 - 0.1087293 \times OI1 - 0.0527731 \times AWI + 0.0251571 \times (sign(OI1) \times (OI1)^2) + 0.0076547 \times (sign(AWI) \times (AWI)^2)$$

(3) Transformed SF-6Dv2 utility values:

$$DisSF\text{-}6Dv2 = Pr(DisSF\text{-}6Dv2 > 0) \times E(DisSF\text{-}6Dv2|DisSF\text{-}6Dv2 > 0)$$

$$SF\text{-}6Dv2Utility = 1 - DisSF\text{-}6Dv2$$

CONCLUSION

- This study provides a mapping framework to estimate EQ-5D-5L and SF-6Dv2 utility values from ADDQoL scores. These algorithms could be used to support economic evaluations, specifically tailored for Chinese T2DM populations.